CLAIMS

We claim:

1. A minimally invasive method for enabling detection of cancerous tissues, the method comprising the steps of:

(a) performing spectral optical imaging of a tissue substantially at one or more key water absorption wavelengths to generate a water absorption image;

(b) performing spectral optical imaging of the tissue at one or more wavelengths of low or negligible water absorption to generate a reference image;

wherein steps (a) and (b) are performed simultaneously or successively in any order, thereby enabling a comparison of the images generated in steps (a) and (b) to identify any substantial difference in water content between a first region of the tissue and a second region of the tissue, such that, changes in water content in normal and cancerous tissues can be detected.

2. A minimally invasive method for enabling detection of tissue in cancerous or precancerous tissues, the method comprising the steps of:

(a) performing spectral optical imaging of a tissue substantially at one or more key water absorption wavelengths including at least one of 980 nanometers (nm), 1195 nm, 1456 nm, 1944 nm, 2880 nm to 3360 nm, and 4720 nm, to generate a water absorption image so as to enable an identification of any regions of the tissue in terms of the water content;

(b) performing spectral optical imaging of the tissue at one or more wavelengths of low or negligible water absorption in the range of 400nm to 6000nm, to generate a reference image;

wherein steps (a) and (b) are performed simultaneously or successively in any order, thereby enabling a comparison of the images generated in steps (a) and (b) to identify any substantial difference in water content between a first region of the tissue and a second region of the tissue.

3. The method of claim 1 wherein the one or more wavelengths of lower or negligible water absorption include at least one of 4500 nm, 2230 nm, 1700 nm, 1300 nm, 1000 nm, and 800 nm.

4. The method of claim 2 wherein the one or more wavelengths of lower or negligible water absorption include at least one of 4500 nm, 2230 nm, 1700 nm, 1300 nm, 1000 nm, and 800 nm.

5. The method of claim 1 further including the step of generating a difference image from the water absorption image and the reference image.

6. The method of claim 2 further including the step of generating a difference image from the water absorption image and the reference image.

7. The method of claim 1 wherein steps (a) and (b) are used to diagnose one or more regions of cancerous tissue in a human prostate by using at least one of: (i) one or more water absorption peaks at 980 nm and 1195nm for deep prostate cancer

detection, and (ii) one or more water absorption peaks at 1456 nm, 1944 nm, 2880-3600 nm, and 4720 nm for surface and subsurface prostate cancer detection or pathology of thin slices of tissues.

8. The method of claim 2 wherein steps (a) and (b) are used to diagnose one or more regions of cancerous tissue in a human prostate by using at least one of: (i) one or more water absorption peaks at 980 nm and 1195nm for deep prostate cancer detection, and (ii) one or more water absorption peaks at 1456 nm, 1944 nm, 2880-3600 nm, and 4720 nm for surface and subsurface prostate cancer detection or pathology of thin slices of tissues.

9. The method of claim 1 wherein steps (a) and (b) are used to diagnose one or more regions of cancerous tissue in at least one of skin, a cervix, a human breast, and other human organs.

10. The method of claim 2 wherein steps (a) and (b) are used to diagnose one or more regions of cancerous tissue in at least one of skin, a cervix, a human breast, and other human organs.

11. A spectral optical imaging system comprising a source of infrared illumination, first and second polarizers, first and second wideband filters, and a charge-coupled device (CCD) camera, wherein the source is equipped to illuminate a tissue to be diagnosed through the first wideband filter and the first polarizer, the CCD camera is equipped to receive at least one of transmitted light and/or back-scattered light from the

tissue through the second wideband filter and second polarizer, the first and second wideband filters include a selection mechanism enabling selection of at least one water absorption wavelength and at least one reference wavelength, the water absorption wavelength including at least one of 980 nanometers (nm), 1195 nm, 1456nm, 1944 nm, 2700-3600 nm, and 4720 nm, and the reference wavelength including at least one infrared wavelength that provides negligible water absorption.

12. The spectral optical imaging system of claim 9 utilized to perform a minimally invasive method for enabling detection of cancerous tissues by:

(a) the CCD camera performing spectral optical imaging of a tissue substantially at one or more key water absorption wavelengths by adjusting the first and second wideband filters to pass electromagnetic energy at least one of 980 nanometers (nm), 1195 nm, 1456 nm, 1944 nm, 2880 nm to 3360 nm, and 4720 nm, to generate a water absorption image so as to enable an identification of any regions of the tissue which have different water content relative to other regions;

(b) the CCD camera performing spectral optical imaging of the tissue at one or more wavelengths of low or negligible water absorption by adjusting the first and second wideband filters to pass electromagnetic energy at one or more low or negligible water absorption wavelengths in the range of 400nm to 1800 nm, to generate a reference image so as to enable an identification of any regions of the tissue which have a different water content relative to other regions;

wherein the CCD camera generates the reference image and the water absorption image simultaneously or successively in any order, thereby enabling a

comparison of the reference image and the water absorption image to identify any substantial difference in water content between a first region of the tissue and a second region of the tissue.

13. The spectral optical imaging system of claim 12 wherein the one or more wavelengths of low or negligible water absorption include at least one of 4500 nm, 2230 nm, 1700 nm, 1300 nm, 1000 nm, 800 nm, 700 nm, 600 nm and 450 nm.

14. The spectral optical imaging system of claim 12 further including a graphical processing mechanism for generating a difference image from the water absorption image and the reference image on a pixel-by-pixel basis.

15. The spectral optical imaging system of claim 12 wherein the reference image and the water absorption image are used to diagnose one or more regions of cancerous tissue in a human prostate by using at least one of: (i) one or more water absorption peaks at 980 nm and 1195nm for deep prostate cancer detection, and (ii) one or more water absorption peaks at 1456 nm, 1944nm, 2880-3600 nm, and 4720nm for surface and subsurface prostate cancer detection; and comparing one or more images generated using one or more water absorption peaks with one or more images generated at wavelengths having no or negligible water absorption.

16. The spectral optical imaging system of claim 12 wherein the reference image and the water absorption image are used to diagnose one or more regions of

cancerous tissue in at least one of skin, a human breast, a cervix, and other human organs.

17. The spectral optical imaging system of claim 11 further including a graphical processing mechanism for subtracting the water absorption images from that reference images so as to enable a correlation of a tissue to be diagnosed with any one of three states including normal, benign, and cancerous tissues, wherein the graphical processing mechanism is programmed to perform the subtracting such that:

$\pm I(\lambda_{NW}) \mp I(\lambda_W) = \Delta I$ represents a plurality of spectra or images

and $\frac{I(\lambda_{NW})}{I(\lambda_W)} = RI$ represents a ratio spectra or images

where λ_W represents one or more water absorption wavelengths, λ_{NW} represents one or more reference wavelengths having no or negligible water absorption, and Δ is an intensity difference between the water absorption image and the reference image.

18. The spectral optical imaging system of claim 12 wherein the source is an LED (light emitting diode) or white light source, the system further comprising a coupling mechanism for coupling the source to a tissue through an optical subsystem including at least one of a filter, a lens, a mirror, a beam splitter, a polarizer, optical fiber, a CCD detector, and a CMOS detector.

19. The spectral optical imaging system of claim 12 wherein the CCD camera is a sensitive red visible to mid-IR CCD or CMOS camera system.

20. The spectral optical imaging system of claim 12 further comprising a computerized imaging system coupled to the CCD camera, the computerized imaging system including a processing mechanism for executing data collection software and for posting images to a display screen.

21. The spectral optical imaging system of claim 11 further including a configuration adjustment mechanism for providing each of the water absorption image and the reference image in a parallel geometry and a perpendicular geometry, wherein the parallel and perpendicular geometries are determined with reference to orientation of the CCD camera, so as to permit a determination of polarization dependency for the water absorption image and the reference image.

22. A minimally invasive method for enabling detection of cancerous tissues, the method comprising the steps of:

(a) performing spectral optical imaging of a tissue substantially at one or more key water absorption wavelengths to generate a water absorption image so as to enable an identification of any regions of the tissue which have at least one of: (i) less water content, and (ii) more water content, relative to other regions;

(b) performing spectral optical imaging of the tissue at one or more wavelengths of low or negligible water absorption to generate a reference image so as to enable an identification of any regions of the tissue which have at least one of: (i) a lower water content, and (ii) a higher water content, relative to other regions;

wherein steps (a) and (b) are performed simultaneously or successively in any order, thereby enabling a comparison of the images generated in steps (a) and (b) to identify any substantial difference in water content between a first region of the tissue and a second region of the tissue, such that, if a first region of tissue has a substantially lower water content than a second region of tissue, the first region of tissue is diagnosed as a cancerous or precancerous tissue region in an early stage of cancer and if the first region of tissue has a substantially higher water content than a second region of tissue, then the first region of tissue is diagnosed as a cancerous or precancerous region in a later stage of cancer.

23. A minimally invasive method for enabling detection of cancerous prostate tissues, the method comprising the steps of:

(a) performing spectral optical imaging of a tissue substantially at one or more key water absorption wavelengths including at least one of 980 nanometers (nm), 1195 nm, 1456 nm, 1944 nm, 2880 nm to 3360 nm, and 4720 nm, to generate a water absorption image so as to enable an identification of any regions of the tissue which have at least on of: (i) less water content, and (ii) more water content, relative to other regions;

(b) performing spectral optical imaging of the tissue at one or more wavelengths of low or negligible water absorption in the range of 400nm to 6000nm, to generate a reference image so as to enable an identification of any regions of the tissue which have_at least on of: (i) lower water content, and (ii) higher water content, relative to other regions;

wherein steps (a) and (b) are performed simultaneously or successively in any order, thereby enabling a comparison of the images generated in steps (a) and (b) to identify any substantial difference in water content between a first region of the tissue and a second region of the tissue, such that, if a first region of tissue has a substantially lower water content than a second region of tissue, the first region of tissue is diagnosed as a cancerous or precancerous prostate tissue region in an early stage of cancer and if the first region of tissue has a substantially higher water content than a second region of tissue, then the first region of tissue is diagnosed as a cancerous or precancerous prostate region in a later stage of cancer.

24. The method of claim 22, wherein the tissue is breast tissue.

25. The spectral optical imaging system of claim 10 utilized to perform a minimally invasive method for enabling detection of cancerous tissues by:

(a) the CCD camera performing spectral optical imaging of a tissue substantially at one or more key water absorption wavelengths by adjusting the first and second wideband filters to pass electromagnetic energy at least one of 980 nanometers (nm), 1195 nm, 1456 nm, 1944 nm, 2880 nm to 3360 nm, and 4720 nm, to generate a water absorption image so as to enable an identification of any regions of the tissue which have different water content relative to other regions;

(b) the CCD camera performing spectral optical imaging of the tissue at one or more wavelengths of low or negligible water absorption by adjusting the first and second wideband filters to pass electromagnetic energy at one or more low or negligible water absorption wavelengths in the range of 400nm to 1800 nm, to generate a reference image so as to enable an identification of any regions of the tissue which have a different water content relative to other regions;

wherein the CCD camera generates the reference image and the water absorption image simultaneously or successively in any order, thereby enabling a comparison of the reference image and the water absorption image to identify any substantial difference in water content between a first region of the tissue and a second region of the tissue.